LUBRICATION

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EDITORIALS

One of the outstanding developments of the present decade is the use of Tractors for agricultural purposes. What the McCormack reaper and other improved agricultural implements meant for the development of agriculture during the middle of the nineteenth century when our wheat, corn, and other crops multiplied a hundred fold in a few years, the tractor has meant during the last few years; in fact, the tractor has come to be such a necessity that our present needs could no longer be supplied by the old methods of farming.

The article on Tractor Lubrication, published in this issue, is especially pertinent, first, because this is the season of the year when tractors must meet the heaviest demands and, second, because the United States Food Administration is making a special appeal for the maximum production of food stuffs. The article strikes at the very heart of the whole tractor problem, namely, the securing of continuous service and of the greatest possible efficiency by means of proper lubrication.

Grease is a product which looks much the same whether it is good or bad. Even a skilled lubrication engineer cannot distinguish a high class grease from a poor grease without either making an exhaustive mechanical test or without separating the mineral oils from the soap and making a test of the mineral oil in the laboratory. A grease might be made up with an inferior mineral oil as its base or with a cheap filler or with an excess of moisture without any of these defects appearing on the surface. The process used in the manufacture of grease also has much to do with its value as a lubricant. Expert knowledge and broad experience as well as high grade materials are required in order to produce the best grade of grease. It is therefore especially important that the user of these products should purchase greases manufactured by responsible refiners. Such a small amount comparatively of motor greases is used by the ordinary consumer that there is not the slightest excuse for risking the use of a low priced or an unknown product. The purpose of the article on "Motor Greases" is to discuss the selection and use of grease both for the pleasure car and for the truck.

THE FRONT LINE IN FRANCE

HOW many people in America possess a clear and comprehensive mental picture of what the war zone in France looks like? John Masefield, the famous English poet who was sent to the front by his government to collect data for the official history of the "old front line," has described that battle-line in vivid phraseology. One of the more startling statements that he made was regarding the terrible mud-stretches where horses and men disappear, their bodies being found in the spring when the sun dries out the long brown morasses. It is an evil-smelling sticky sea of mud during the rainy seasons and reaches like a long dark gash across the once pleasant fields of France. There are times when this war zone resembles the Inferno of Dante. A steady booming may be heard all through the day with now and then the sharp crack of snipers' rifles. When a trench-raid or an advance is in progress the sound is terrible to hear, shrill hissing, loud crashes, thunderous reverberations and rifle-fire like the steady roar of rain. A crimson sulphurous cloud of smoke hangs over the battle-zone, dulling the sun which shines through it like a large red lantern.

A visitor traveling along the front will hardly ever see men. They have tunnelled into the bowels of the earth and conceal themselves there. Occasionally a clay-covered, unshaven figure will rise out of the ground and, in a hoarse voice, ask you for news of the war. These men at the very front, living the weird life of a modern fighter, combating poisonous gases, liquid fire and death from the clouds besides the ordinary shells and bullets and bayonets, do not know as much as we in America know about the progress of this war.

One thing we must never forget, however, and that is that ignorance of how things are going does not cause disaffection and despair among the allied fighters. Their faith in those back home is wonderful to behold. Enduring this terrible life in a world of mud and death is but the means to a great end and the fighters have strength and moral will to stand it because they know that they have embattled, wealth-mobilized countries behind them, warranting their belief in ultimate victory.

America must never let her young men in those trenches think differently. They are over there now and they are there to stay until the bells ring for peace. America has sent them over to fight her battles, our battles, and America is responsible for their maintenance there. In this Third Liberty Loan campaign every man and woman in this country must express in no uncertain terms whether or not he desires to do his bit in bringing those brave young men safely back from that world of mud.

TRACTOR LUBRICATION

THE United States Government has asked that every available square foot of tillable land be planted this spring to meet the food demands of our Allies and to supply the boys "over there." The acreage planted will be greater than ever before, but the efforts of our farmers will be greatly handicapped by the lack of labor. Large numbers of men have been drawn to the manufacturing centers by high wages in munition and other manufacturing plants, and many more have been called by the U. S. Government for war service.

This enormous shortage of labor will be met partly by the increased use of farming machinery, particularly the tractor, which has now been developed to the point where it is of recognized value in crop production.

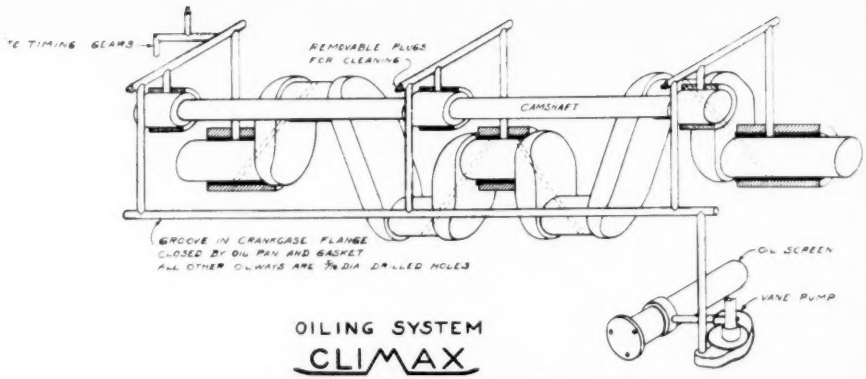
This year, above all, it is our duty to "do our bit" and keep these tractors running every possible moment in working the ground, planting the seed, cultivating the crop, and getting the food to the markets and warehouses. There is no tractor made which can be operated without a lubricant for the motor and other working parts, and a tractor can give 100% service only when its moving parts are protected against wear and breakdown by the use of a one hundred per cent. efficient lubricant. Because of the generally rough character of the service, tractor operators always have considered that almost any oil was good enough as long as the tractor would run. Tractor motors, however, are just as well made and tractors usually cost the farmer just as much as pleasure cars and should be lubricated with just as high grade oil. A little attention paid daily to the lubrication of the tractor and to the use of suitable lubricants of high quality will give great return in improved operation and freedom from delays from worn-out parts.

The tractor consists essentially of a motor, and a means of delivering the power developed to the tractor wheels and draw bar or to the pulley. There are many forms, arrangements and refinements of these fundamental necessities and the proper functioning of them all depends very considerably upon the way they are lubricated.

Tractor motors may consist of one, two, four, six or eight cylinders of numerous designs though they can be classed generally as horizontal and vertical motors. Out of 159 models of 1917 tractors examined, 112 or 70%, were equipped with vertical motors, most of them following very closely the design of automobile engines. The lubrication of these motors may be considered generally as depending largely on the design of the motor, the type of oiling system, the fuel used and the operating conditions.

The influencing factors in the motor design are the piston and piston ring clearance, the method or point of ignition, the cooling system, the construction of the bearings, and the general design. The effect of these elements is briefly discussed in an article on "Lubrication of Internal Combustion Engine Cylinders" which appeared in the February issue of *Lubrication*. All these things are fixed by the tractor manufacturer and cannot be altered by the operator.

Motor oiling systems may be divided into two general classes; one, in which the oil is placed in an enclosed crank case and is carried to



OILING SYSTEM
CLIMAX
MODEL K TRACTOR ENGINE

the surfaces to be lubricated by oil pipes or by splashing, and returns to the crank case to be used again; the second, in which the oil is supplied to the bearing surfaces and cylinders by means of a separate lubricator, which does not use the oil coming from these surfaces a second time. About 40% of the various 1917 models was equipped with force feed lubricating systems, although it is probable that a much greater percentage of the total number of tractors that were built were so equipped because of the large number made by some companies which used the mechanical lubricator.

The enclosed crank case type of oiling system is similar to that employed by the automobile manufacturers. It may be arranged in a number of ways, the oil being supplied to the cylinders by splash from cranks, or by force feed from the wrist pins, the bearings being lubricated either by splash or oil leads and pipes with and without circulating pumps. The advantages of this method are the automatic delivery of a flood of oil to all moving parts, when the motor is running, and the catching of all oil from the bearings for re-use. The principal disadvantage is the contamination of the lubricating oil by fuel leaking past the piston rings into the crank case, and by particles of carbon, grit, and bits of metal worn from bearings and piston rings. The heavier particles, of course, settle to the bottom of the crank case and do no damage, but the thinning down of the lubricant through the admixture of liquid fuel leaking past the piston rings, or gases leaking through and later condensing in the crank case, is a very serious matter. This may be reduced, if not altogether prevented, by proper motor design, improved methods of carburetion, and the use of those lubricants that will form the best seal for the piston rings and will be least affected by any leakage which does get through.

Piston leakage may be reduced by the tractor builder by means of proper piston and piston ring design, and by efficient methods of carburetion to reduce the amount of fuel present in the cylinder in an unvaporized condition. The tractor operator may help himself by careful attention to the motor, changing worn piston rings, putting in new ones, using the best oil he can get and draining it out when he finds that it is becoming thin in the crank case. As the oil is thinned down it loses its body and does not properly seal the piston rings, thus increasing

the amount of fuel leakage which still further thins down the oil. The oil refiner can do his bit by furnishing the oil best suited to the requirements of the motor.

The mechanical lubricator consists of an automatically driven device, actuated by the motor when it is running, to distribute oil thru pipes to the cylinders and bearings in regular quantities. The oil flow starts and stops with the motor, and the amount of oil, after the feeds have once been regulated, varies directly with the speed of the motor. The supply of oil fed to the various bearings may be adjusted to any desired quantity by regulating valves connected with each feed line.

The advantage claimed for the use of mechanical force feed lubricators is a regular, predetermined supply of fresh clean oil, uncontaminated with condensed fuel, to all cylinders and principal bearings. The delivery of oil to the bearing surfaces is constantly in plain view thru a glass indicator. Of course the oil from the bearings and cylinders is not used again for their lubrication, and unless other use for it is provided this oil goes to waste.

The mechanical lubricator is provided with a crank for pumping the oil by hand to the bearings when the engine is not running, and the operator should always turn the crank forty to fifty revolutions before starting the engine so that oil is pumped by each plunger of the lubricator. This is very important and should not be overlooked because it gives the bearings oil for immediate use.

The fact that there is oil in the mechanical lubricator is not enough to insure lubrication of the bearings. Look at the glass indicator on the lubricator often, to see that each plunger is doing its work; also be sure that the oil is reaching the bearings. If the oiler doesn't seem to be working properly, take no chances, but investigate by removing the end of the pipe at the bearing and turning the crank to see that oil goes through the pipe and that the opening is not clogged up.

Sixty-four per cent. of the different types of tractors built in 1917 was equipped to burn kerosene fuel, a few being able to start on kerosene but the majority starting the motor on gasoline. A motor burning gasoline is not as hard to lubricate as one using kerosene fuel, because almost any good carburetor will sufficiently vaporize gasoline to prevent excessive condensation in the cylinder. Kerosene, however, having a much higher boiling point, is considerably more difficult to vaporize and has a greater tendency to liquefy in the cylinder. This condensed kerosene flows down the cylinder walls, washes off the lubricating oil, and leaks past the piston rings into the crank case, contaminating the oil. Many tests have been made on kerosene tractors with different lubricating oils, and it is a very frequent occurrence to find that the amount of oil in the crank case has increased rather than decreased. This increase, of course, can be due only to contamination from the kerosene fuel.

The condensation and leakage of kerosene are matters for the consideration of all manufacturers of carburetors and motors, and while considerable progress has been made, there is still room for improvement in carburetor design to relieve this serious condition.

Tests recently made, which are summarized here, show clearly that the lubricant used has a very considerable effect on the amount of

kerosene consumed per brake horse power and the amount of fuel leaking into the crank case.

The test summarized below was conducted on a Climax engine by the engineers of The Texas Company co-operating with the engineers who built the tractor.

ENGINE

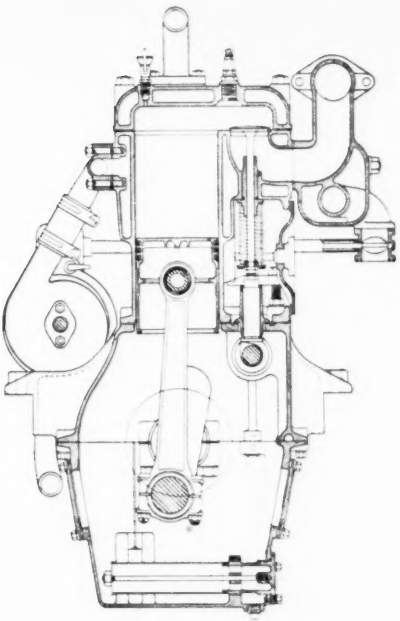
Make	Climax
Type	4 stroke cycle
Cylinders	4.5″ x 6.5″
Speed	800 r.p.m.
Control	Throttle and governor
Governor	Centrifugal
Carburetor	Kingston
Oiling system	Force-feed type, oil forced under 9 lb. pressure to all moving parts
Brake	Pony-brake belted to pulley on tractor

Oil Used	Competitive Heavy Bodied (High Viscosity)	Texaco Tractor Oil Correct Body (Correct Viscosity)	Texaco Oil Light Bodied (Low Viscosity)
Hours test ran	7.	7.	7.
B.h.p.	20.0	20.4	19.13
Oil placed in reservoir, qts	10.	10.	10.
Oil increase, pts	3.0	3.0	3.5
Oil increase, pts. per b. h. p. hr.	2.5	2.45	3.27
Kerosene consumption, qts., 7 hrs	18.5	18.5	20.5
Kerosene consumption, b.h.p.hr	.132	.123	.154
R.p.m.	637.	652.	670.
Average room temp., deg. F.	70.1	69.6	62.
Average crank case temp., deg. F.	121.	114.	117.
Average temp. difference, deg. F.	50.9	44.4	55.
Average cooling water temp., deg. F.	150.	150.	150.

Before each test the crank case was drained, slushed out with kerosene and filled with a new supply of oil, the initial charge being ten quarts. At the beginning of each test a ten-minute run was made with gasoline and twenty minutes with kerosene to warm up the engine and adjust the pony brake.

These tests bring out the fact that there is a definite body or viscosity required in an oil to meet the conditions of tractor motor operation, particularly when burning kerosene. The heavy bodied competitive oil showed an increased fuel consumption of 7.3% over the correct bodied Texaco Lubricant, due probably to the fact that the oil was so heavy as to have a dragging effect on the motor. This is clearly indicated by the speed of 637 r.p.m. and the fact that it was impossible to get this engine up to speed when using this oil. The increased crank case temperature from 44.4° F. to 50.9° F. also shows the effect of the heavy bodied oil in increasing frictional temperatures. When a comparatively light bodied oil was tried, the kerosene used per b.h.p. increased 24.4%, and the amount of fuel leaking into the crank case increased 13.3%. The rise of over 10° F. in the crank case temperature difference can hardly be accounted for in any other way than that the excessive leakage of hot gases and liquid fuel past the piston rings from the cylinder raised the temperature.

The admixture of such a quantity of kerosene, 17.5%, in the case of the competitive oil and the Texaco Tractor Oil, thinned them both down considerably, but the drop in the viscosity of the heavy competi-

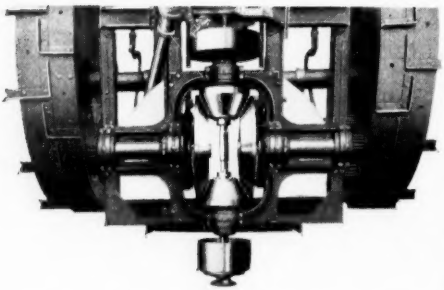


CLIMAX
MODEL K TRACTOR ENGINE

tive oil was 40%, whereas the drop in viscosity of the correct Texaco Oil was only 30%. This viscosity drop indicates very clearly the ability of the oil to stand up, even when contaminated, and shows that a very high initial viscosity is not always indicative of superior quality.

The conditions under which a tractor is operated are somewhat different from those encountered by a truck or a pleasure car, and rather than permitting of the use of a cheaper grade of oil, as seems to be the idea prevalent among tractor operators, require just as careful selection of a lubricant as does the pleasure car. Probably sixty per cent. of the year's operating takes place in spring and fall, and the feature of starting the motor in cold weather, frequently below freezing point, makes the question of proper piston ring seal a very important proposition. If a light bodied oil is used to meet the requirements during cold weather the piston seal will be sacrificed, reducing the compression and increasing the difficulty of starting. The fuel losses will be very large, particularly when kerosene is used for starting.

During the summer months, the tractor operates in the intense heat of the sun at full load, and very high cooling water temperatures may result. While the tractor is used for threshing, the motor is operating at full capacity without any lateral movement and, as may be expected, the cooling capacity of the radiator is lessened. The high temperatures of the motor, however, improve the combustion of the fuel and reduce the leakage, which tends to balance the effect of high temperature thinning down the oil. Experience has shown that after carefully consider-



Texaco Crater Compound on these cones makes speed changing easy. Recommended by Square Turn Tractor Co., Chicago, Ill.

ing all conditions, a tractor should use the same grade of oil in both winter and summer.

While we have seemingly neglected the question of carbon, this is of considerable importance. The general causes and influences are discussed in the article on "Lubrication of Internal Combustion Engines" in the February issue. Improved methods of carburetion will tend to reduce the amount of carbon formed, particularly when low grade gasoline and kerosene fuels are used, a point which should be given careful attention by the motor builder.

There are two methods usually employed in moving the tractor over the ground, the use of a broad wheel with some means of gripping the earth's surface, and that of the caterpillar or track layer type. Twenty-four models of caterpillar tractors of various designs were built last year, not including the "tanks." These tracks and driving mechanisms are, of course, covered with mud, water and dirt, which rapidly wears out the parts unless they are protected by an efficient lubricant. In order to lubricate them they have to be thoroughly cleaned, which is, of course, a very dirty, disagreeable job, and when it is done the operator would like to feel that it will last a long time.

A very heavy bodied, adhesive lubricant which will not wash off, applied with a brush to the inside of the track, links, rollers, sprockets, chains, etc., will lubricate these parts and effectually prevent their being destroyed by the cutting action of grit. A very satisfactory way of handling the lubrication of these parts is for the manufacturer to dip them all in this heavy lubricant at the factory during the assembling of the tractor, so that there will be proper lubrication on all parts when the purchaser receives the tractor; then the operator will not have to spend his first day greasing up.

Between the motor and the final drive there must be a device for transmitting the power developed by the motor, and this usually consists of two pieces of mechanism, a speed changing device, called a transmission, and the final drive to the rear wheel or caterpillar. The transmission consists of spur gears for changing speed, and gear shaft bearings. Transmission bearings are of several types, the relative use during 1917 being as follows: Roller 43%, babbitted 41%, ball 11%, bronze 5%. Babbitted and bronze bearings of the sleeve type require a thinner bodied lubricant than roller or ball bearings, as the oil must be capable of flowing through comparatively small clearances to the parts to be lubricated. Eighty-five per cent. of all transmissions is enclosed in a casing which is usually made tight to hold oil, and it is advisable to use a very heavy oil which will lubricate the bearings and lubricate, as well as protect, the gears from wear and prevent noise in operation. The gears, of course, should have a very heavy lubricant, but its body must be modified by the requirements of the bearings. Roller and ball bearings on the other hand,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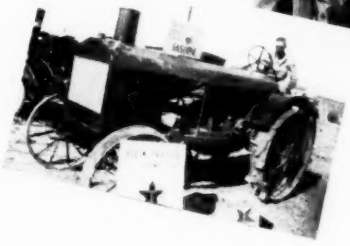
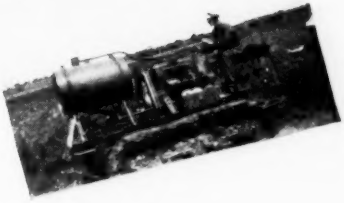
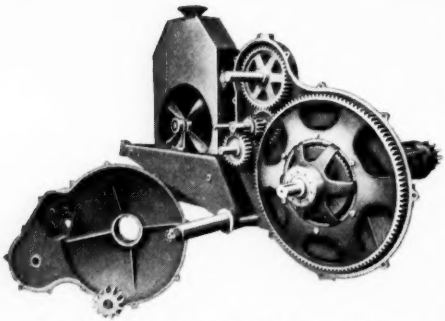






The Transmissions of the Moline Plow Company, who recommend the use of Texaco Crater Compound

have no small oil grooves, and a heavier bodied lubricant will be satisfactory.

If the tractor is used in cold weather the pour test of the lubricant is of great importance, as a solidified lubricant may cause much damage when an attempt is made to start the tractor. The lubricant should not channel when the gears are running, as so many of the greases do, the grease sticking to the side of the case and not flowing back to the gears so as to afford continuous lubrication.

If the transmission is not enclosed, the gears require a lubricant which will adhere without being thrown off by centrifugal force, and which will not run off because it has been thinned down by water or cut off by sand or dust. It should protect the gears from wear and permit them to run quietly. The bearings of this type of transmission are usually lubricated by means of compression grease cups.

In general, if the transmission is oil tight, and equipped with bronze or babbitted bearings, a lubricant like Texaco Thuban Compound will give very efficient results. If the casing is not so tight, or if the bearings are roller or ball, a heavier bodied lubricant such as Texaco Crater Compound may be used. All exposed gears should be coated with Texaco Crater Compound.

The final drive may be spur gear, internal gear, roller pinion, chain, worm, bevel or friction gears. The spur gear is the predominant type, with the chain drive running second. Sixty-four per cent. is enclosed. The final drive, of course, takes the greatest shock and strain of the work of plowing, and the gears need an exceptionally heavy bodied, adhesive lubricant that will stand up to the service, unaffected by plowing or road dirt. Texaco Crater Compound heated and applied with a brush to the clean metal of the gear teeth has given excellent results, reducing wear and saving many gears.

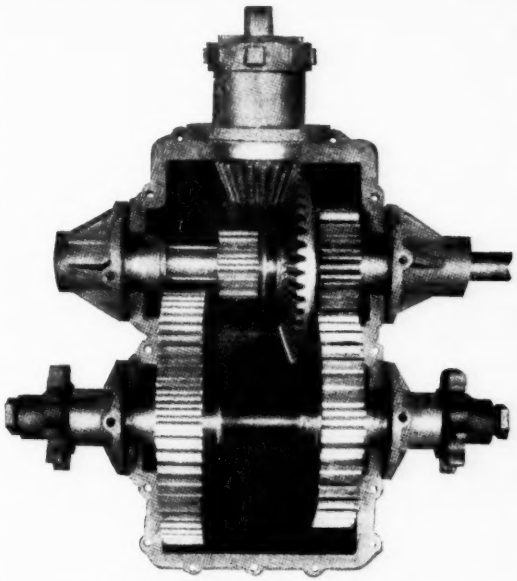
Chains may be dipped in boiling hot Texaco Crater Compound, and hung up to drain. It will work into every joint and keep out grit, as well as lubricate.

Wheel hubs, and all bearings equipped with grease cups require a clean, smooth, medium bodied grease, such as Texaco Motor Cup Grease. All grease cups should be given one or two turns once or twice a day. Other bearings not fitted with grease cups may be lubricated with a little motor oil.

The tractor builder, the operator, and the oil refiner are jointly and severally responsible to the people of the United States for the production of a maximum crop, and unless each does his share, our Allies, depending on us for food, may go hungry on account of our crop failing to meet their requirements. The operator should keep his tractor in the best possible condition, properly lubricated with high grade oils, and should help the oil refiner to meet the demands of the Government and the war industries for greater oil supplies by saving every possible drop.

Tractor builders undoubtedly have the greatest opportunity for service, primarily in designing motors and accessories with efficient lubrication in view, and in instructing the operator concerning the proper care and use of suitable lubricants.

Through the close co-operation of the tractor builder and the oil manufacturer, each confiding to the other his experiences and the natural limitations of his product, great good may result. The Lubrication Engineers Association of The Texas Company has an unusual opportunity to aid both operator and builder through the clearing house of its many members' experiences concerning tractors of practically all types operating under every conceivable condition. These engineers are at the service of the users and builders of tractors in the solving of lubrication problems.



The Nilson Tractor Company Recommend Texaco Crater Compound for their Transmissions

MOTOR GREASES

WHEN a man starts out with his family for a week end trip in the car, he wants to feel confident that the trip is going to be a source of pleasure, unmarred by disagreeable breakdowns, flat tires and motor trouble. On his return he would like to be able to put the car in the garage ready to make the trip all over again the next day without calling on the repair man to make a general overhauling.

The merchant who owns an automobile truck wants to know that when the truck leaves his warehouse with a load of goods they will be delivered on time. He doesn't want to have to send out another truck to reload the merchandise from the first one because it has broken down on the way.

The motor vehicle manufacturers have tried to foresee all the accidents that may occur and the troubles that may arise, and have designed their cars to prevent, as far as is possible, such accidents and difficulties. The best of cars, however, will not operate satisfactorily day in and day out, unless the lubrication of all bearing surfaces is given regular attention and fresh lubricant of high grade and suitable character is supplied at regular intervals.

The builder of the motor vehicle realizes this and usually includes in the instruction book which accompanies each car a diagram showing

the points to be regularly attended to, the class of lubricant to be used, whether grease or oil, and the frequency with which fresh lubricant should be supplied. These instructions are based on the motor car builder's experience and should be closely followed. In many cases it will be found that certain grades or brands of oil have been recommended as being suitable for the motor, but generally speaking, no information is given to help the car owner select from the varieties of grease sold, something that will lubricate the bearings, last a reasonable length of time, and that can be purchased at a fair price. It always seems to be left to the garage man to supply some "dope." There are low-priced greases and there are high-priced greases, and unless the car owner is familiar with what constitutes a good grease he will be unable to get good service. Owing to the present high cost of all the materials entering into the manufacture of good greases, it is impossible for a high grade lubricant to be made and sold at a low price and the purchaser may rest assured that if the price is low the grease is of poor quality.

Greases are used on motor cars in places where the use of a fluid lubricant is not practicable because of the method of application or the construction of the bearing surface or housing. There are certain bearings, the mechanical construction of which is such that if an oil were used it would leak or run out, leaving the bearing surface dry. There are also certain places rather difficult to reach, on which it is desirable that the lubricant last for a considerable length of time without renewal. At all of these points a suitable grease will last longer than an oil, and will reduce the labor and attention required to keep the parts lubricated.

The most common usage of grease on automobiles and tractors is in the compression cups, wheel hubs, spring leaves, steering wheel gears, transmission and differential.

Compression cups are employed on practically all parts of the chassis requiring lubrication, including spring belts, steering spindles and knuckles, fan pulley, rear wheel bearings, etc., where an oil will not remain on the bearing surface for any great length of time. A high grade grease of medium or heavy consistency should be used, and the grease cups should be given one or two turns every one hundred miles, or every morning in the case of motor trucks.

Wheel hubs are subjected to terrific road shocks and strains and, even if originally constructed to hold a liquid lubricant, after a few hundred miles they will leak and lose oil very rapidly. Hubs, therefore, are usually lubricated with a grease, which should be of such nature that it will remain in the hub without drying up or leaking out for at least a thousand miles. Some greases will last longer, and experience with the grease will show how long the car can run before the hub cap should be removed and the hub packed with fresh grease.

As practically all wheels now are equipped with ball or roller bearings, the grease used should have certain definite characteristics. The highly polished surfaces of the balls, or rollers, and races, while extremely hard, can nevertheless be destroyed by impurities in the grease.

In an issue of *American Machinist* several years ago Mr. W. L. Batt, General Manager of the Hess-Bright Mfg. Co., said: "The addition of mica, ground cork, wood and such substances frequently added to the grease to overcome noise in gear cases of automobiles, is a positive menace to the ball bearing, since

this foreign matter opposes free ball rotation. If it be present in large enough amount, the result may easily be that the balls are wedged between the raceways and actual fracture may result. Certainly the free rolling quality of the ball bearing will be lost.

"The question of the beneficial effect of graphite in ball-bearing lubrication is one often asked. The answer is simply that graphite in any shape or form that will settle and pack with time when quiescent cannot be of assistance to the ball bearing itself."

The manufacture of greases and the study of the ingredients used in making them is very interesting. Formulas and general specifications can be given, but it seems to be generally acknowledged that rules for manufacturing are of little use, the success of the manufacturer depending more upon the skill employed in compounding the lubricant than upon the list of ingredients, provided, of course, that high grade materials are used.

Generally speaking, greases are composed of a mineral oil base thickened to the proper consistency by the addition of an animal or vegetable oil soap. It is absolutely essential that a highly refined lubricating oil should be used.

Good motor greases are smooth, homogeneous in body, and the constituent elements are so well combined that they will not separate in use or when standing in the package. If the grease is not properly made the mineral oil base will squeeze out, leaving a residue which may cake or gum and increase the bearing friction rather than decrease it. Owing to the present high cost of the good animal and vegetable oils used in grease manufacture, a number of concerns are substituting rosin as the thickening material. Rosin, of course, is not a lubricant and will gum up and greatly increase the bearing friction. Its low cost is the only reason for its use. Other cheap greases contain an excessive amount of water, introduced to increase the weight and reduce the manufacturing cost per pound.

Texaco Motor Greases are made from the finest material it is possible to secure, put together by men skillful and experienced in their work and backed up by expert knowledge of practical requirements.

There are also many greases sold for motor vehicle lubrication which contain graphite in some form. Graphite greases are suitable for many purposes, but because their experience has justified their action, practically all of the ball and roller bearing manufacturers have condemned the use of graphite.

Even the very finely divided or deflocculated, small particles of graphite pack in front of the balls, preventing their rolling and causing them to slide and abrade the surface until the graphite becomes packed so hard that the ball is first halted and then rides over the small mound, only to repeat the sliding process until stopped by another mound of packed graphite.

Steering wheel gears are sometimes lubricated with a motor grease, but experience has shown that a very heavy adhesive oil, such as is recommended for the transmission and differential, will give the most satisfactory results.

The stress and strain placed on the springs when an automobile is traveling over the road causes the spring leaves to slide back and forth a little, lengthwise. These sliding surfaces have to be properly lubricated or the springs will be stiff and squeak. The lubricant is always placed between the leaves of the spring when it is originally assem-

bled, but after about 1,500 or 2,000 miles the springs become dry and it is necessary to relubricate them. This is done by spreading the leaves a little and inserting a grease or a heavy oil. If a graphite grease or other filled grease is used, the oil base evaporates, leaving only the filler, which, of course, has no lubricating qualities. Experience has shown that a very heavy, adhesive oil such as Texaco Thuban Compound, the same as that recommended for the transmission and differential, will be retained between these leaves for the greatest length of time and by giving efficient lubrication will afford a smooth riding car.

A great variety of greases and oils having a wide range of characteristics are being sold for the lubrication of transmissions and differentials. Because these parts consist of both gears and bearings enclosed in a single casing, the lubricant used must be suitable, as nearly as is possible, for both. To secure most efficient lubrication the bearings need a comparatively light oil, while the gear teeth, on the other hand, ought to have a very heavy bodied lubricant to insure quiet running. These two extremes must be met by a compromise which will most satisfactorily take care of both.

Timken, in the February, 1918, issue of *Timken Magazine*, says of rear axle lubrication:

"Do not use any lubricant which has solid matter in suspension. Graphite, sawdust, asbestos fibre, mica or any similar products, irrespective of their form, must not be used. Use only a good high-grade oil free from acid and grit that will stand a cold test of zero or below."

Texaco Thuban Compound has been especially prepared to meet the requirements of rear axle lubrication and will give uniformly satisfactory results in oil-tight housings in warm as well as cold weather. Of course, if housings are not oil-tight a grease which will not leak out must be used.

A little help from the service department of the automobile manufacturers in the way of suggestions as to what are good greases, and a little insistence on the part of the car owner that good lubricants be furnished him, will accomplish a great deal in the way of decreased cost of up-keep and general all-around improved service.

TEXACO THUBAN COMPOUND USES

By S. F. Lentz

PRIMARILY, Texaco Thuban Compound is a gear lubricant. The lubrication of gears is accomplished in two ways,—by local applications, as on large rough, open gears, and by enclosed case bath lubrication, such as automobile transmissions, speed reducers, worm gears, etc. For the first named purpose we have Texaco Crater Compound and it will therefore not be considered in this article. For the latter purpose, Texaco Thuban Compound is specifically intended.

Manufacturers of preparations used as transmission lubricants, regardless of the exact nature of their product as it is placed on the market, will agree that the required characteristics of the lubricant are about as follows: It must have sufficient body to cushion the gear teeth and maintain a pressure-resisting film between the tooth surfaces; it must be adhesive, so that it will resist the wiping effect occasioned by the sliding contact; it should be entirely free from any pos-

sibility of gumming; it should not be easily or greatly affected by temperature changes; it should be strictly free from acids or other chemicals which might act on the metal surfaces; it must be light enough to properly lubricate any roller, ball or sleeve bearing which may be incorporated in the gear mechanism; it must be heavy enough to prevent easy leakage from a gear case; and, finally, it should be a product which, if subject to high temperatures, either temporarily or continuously, will not readily decompose—in other words, it must not "break down" and lose its lubricating value.

It is interesting to check the characteristics of Texaco Thuban Compound with those given above. Its adhesive qualities are such that an absolute film is maintained between surfaces coming into contact, regardless of pressure, and this same quality insures quietness of operation; it is not greatly affected by temperature conditions as is evidenced by its use in winter and summer in automobile transmissions and differentials; it contains no acids or other injurious chemicals,—in fact, it is used as a metal protective coating and is not affected by acid fumes or water, etc.; it will not gum as it does not decompose either from high temperature or long and hard wear; it is sufficiently fluid to successfully lubricate roller, ball or sleeve bearings, and yet it has enough body to prevent leakage from a gear case under ordinary conditions.

It is believed by some that a lubricant for this purpose should contain a filler to give sufficient body to deaden the noise of operation. This filler is never a lubricant and reduces the lubricating value of the finished product, at the same time causing the product to be more susceptible to temperature conditions and permitting a sort of "separation" or breaking down. The filler also has a tendency to gum or harden and form objectionable coatings over the parts to be lubricated.

Texaco Thuban Compound is entirely free from troubles of this nature, as it is a straight mineral product, being all lubricant and containing no filler of any kind.

The method of using ordinary gear greases in gear cases is to pack the case full, as, if there should be any less than this amount in the case, the gears would simply channel thru the grease, particularly in cold weather. This grease could not flow back to fill the space and thus after a few revolutions the gears would actually be operating without any lubrication. This is likewise true, in a slightly different manner, of the ordinary semi-liquid gear preparations, which do not have the proper adhesive qualities. With the latter, the gear case must be filled practically full or at least up to the point of mesh of the highest pair of gears, as otherwise a sufficient amount of the product will not be carried around to lubricate the gears and other parts.

When Texaco Thuban Compound is used it is only necessary that the lowest gear in the case dip in the lubricant sufficiently to cover the lowest gear tooth. The adhesiveness of Texaco Thuban Compound will then insure its being carried around and distributed to all necessary parts.

If the gear speeds are rather low or if there are two or more distinct sets of gears separated some little distance in the case, or if there are several bearings of any type, located near the top of the case, it is necessary that the Texaco Thuban Compound level be carried somewhat higher, in order that a sufficient quan-

tity of it may be splashed or thrown upon the parts to be lubricated.

Worm gears are ordinarily the hardest to lubricate as the friction is of a sliding nature which has a wiping effect upon the lubricant. The worm is also fitted with an end-thrust bearing, either roller or ball, or simple metal plates, and quite often the designer of the machine has not made ample allowance for the entrance of the lubricant to this bearing.

It is desirable to carry the lubricant level in a horizontal worm gear case to a point where the worm is completely immersed. Of course, this is not practicable if the worm is located horizontally at the top of the case, in which event the level should be such that the gear driven by the worm dips at least the length of a tooth. This latter also applies if the worm is located perpendicularly in the case.

It is not possible to give any accurate idea as to the quantity of Texaco Thuban Compound required for any certain sized gear case. This will depend upon the distance of the bottom of the lowest gear from the bottom of the case; upon how completely the case is filled with gears; and upon other conditions which can only be determined upon seeing the equipment.

If in gear cases of any kind it is found that the proper level of Texaco Thuban Compound considered with regard to the gears, is above any shaft which may project thru the case, it is sometimes found that the lubricant will have a tendency to leak out slightly around the shaft. Usually the designer has provided the shaft with a felt washer at this point, and if it is properly placed there should be no leakage, but if there is no washer, it is almost always possible to add one.

One general direction regarding Texaco Thuban Compound is, "Do not use too much." A case full of it, other things beings equal, will not lubricate any better or more efficiently than just the necessary amount—in fact, too great a quantity is undesirable as it adds considerably to the power consumption.

Besides being an especially desirable lubricant for gears of all kinds operating in cases where the lubricant can be introduced in the form of a bath, Texaco Thuban Compound readily lends itself to other lubrication purposes.

It may be used in the differential, the universal joints, and the steering knuckles of automobiles and trucks. It will add to the riding qualities of any automobile and practically do away with "squeaks," if a small quantity is introduced between the leaves of the springs. If used sparingly it cannot be outclassed as a belt dressing for canvas belts. It can be used quite often to advantage in place of Texaco Crater Compound to lubricate by local application large open gears which are subjected to low temperatures and where the cold metal prevents Crater Compound from distributing properly, especially when it is impossible to provide adequate heating facilities. In lieu of Texaco Crater Compound, it will, if heated to a very fluid condition, give excellent results on wire ropes as a dressing, especially in cases of ropes which are exposed to winter temperatures, where the cold metal has a tendency to chill the heavier Crater Compound before it properly spreads over, and penetrates into, the rope. If automobile or truck chains or other chains of like type are immersed in hot Thuban Compound for a few minutes, it will penetrate to every bearing surface of the rollers and pins, and as the pressure will not force it out, the chain will afterward need only occasional outside applications.